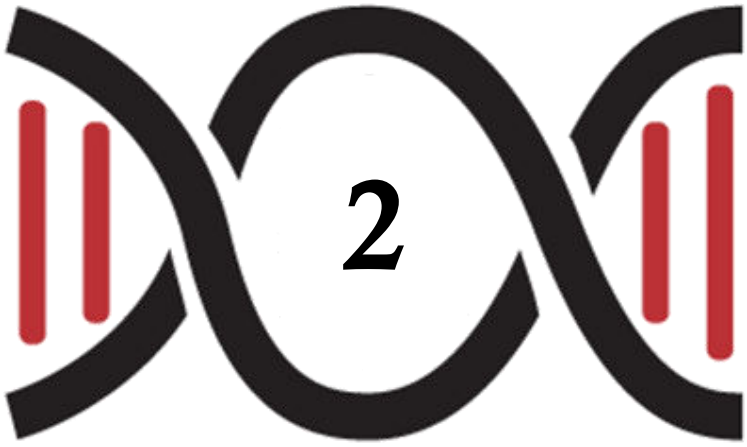
LONDON SCIENCE COLLEGE

AQA A2 BIOLOGY

TOPIC 6

ORGANISM RESPONSE TO THE ENVIRONMENT



1 Scientists investigated the control of blood glucose concentration in mice. They kept a group of normal mice without food for 48 hours. After 48 hours, the blood glucose concentrations of the mice were the same as at the start of the experiment.

(a) Explain how the normal mice prevented their blood glucose concentration falling when they had **not** eaten for 48 hours.

.....

.....

.....

.....

.....

.....

[Extra space] .....

.....

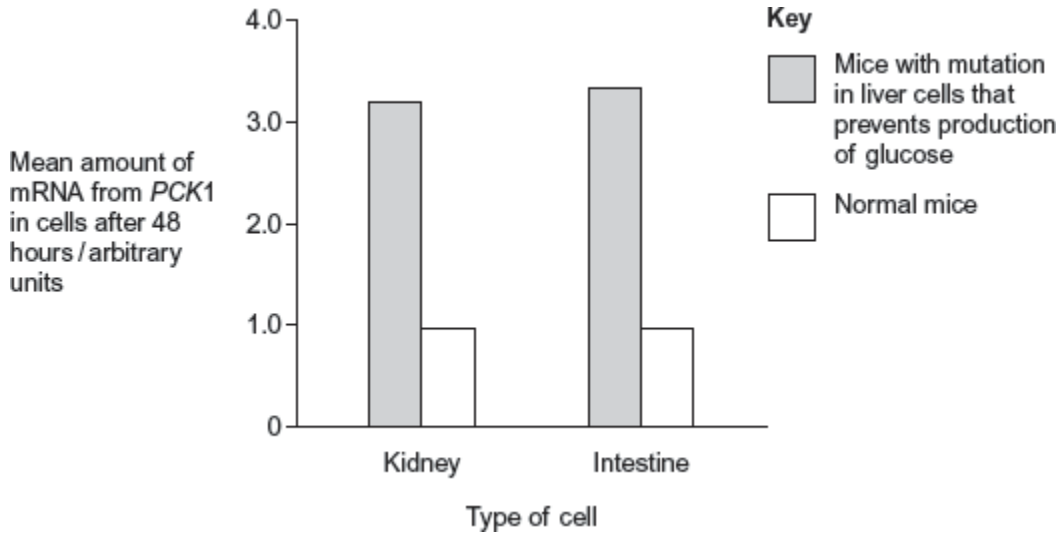
.....

(3)

The scientists then investigated mice with a mutation that prevents their liver cells making glucose. They kept a group of these mice without food for 48 hours. After 48 hours, the mean blood glucose concentrations of the mutant mice and the normal mice were the same.

The scientists investigated how blood glucose concentration is controlled in these mutant mice. An enzyme required for synthesis of glucose is coded for by a gene called *PCK*1. The scientists measured the mean amount of mRNA produced from this gene in cells from the kidneys and intestines of normal mice and mutant mice. They did this with mice that had previously been without food for 48 hours.

The scientists' results are shown in the graph.



(b) Use information from the graph to suggest how blood glucose concentration is controlled in the mutant mice, compared with the normal mice.

.....

.....

.....

.....

.....

.....

[Extra space] .....

.....

.....

(3)

(c) The scientists performed statistical tests on the data shown in the graph, to see whether the differences in the amount of mRNA in cells from normal and mutant mice were significant. Both the probability values they obtained were $p<0.01$.

Explain what this means about the differences in the amounts of mRNA produced.

.....

.....

.....

.....

.....

[Extra space] .....

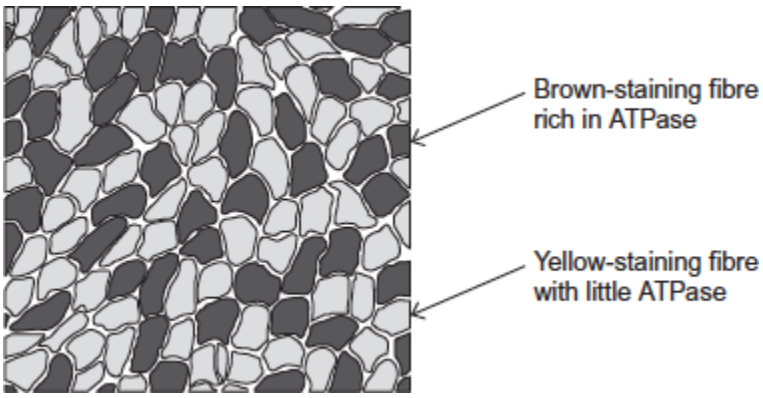
.....

(2)

(Total 8 marks)

2 Slow and fast skeletal muscles both contain slow and fast muscle fibres but in different proportions. The proportion can be determined by observing stained sections of muscle under a microscope. The stain used reacts with an ATPase enzyme. Muscle fibres containing a lot of this ATPase stain brown. Fibres containing little ATPase stain yellow.

The diagram shows stained muscle fibres in a section taken from a muscle.



(a) Both slow and fast muscle fibres contain ATPase.

Explain why.

.....

.....

.....

.....

(2)

(b) The tissue in the diagram came from muscle with a high proportion of brown-staining fibres. Was the tissue removed from slow or fast skeletal muscle?

Explain your answer.

.....

.....

.....

(1)

(c) The muscle tissue in the diagram had been stained for viewing with a microscope.

What is the evidence that it had been stained for viewing with an optical (light) microscope? Explain your answer.

.....

.....

.....

.....

(2)
(Total 5 marks)

3 Researchers investigated whether the blood supply to slow and fast muscle fibres in a muscle changes with age. They used diaphragms taken from hamsters (*Mesocricetus auratus*). The diaphragm is in constant use for breathing. They took diaphragms from groups of young, adult and old hamsters.

They removed the diaphragm from each animal and took a sample of muscle tissue.They examined it under an optical (light) microscope. For each sample they selected several fields of view at random. In each field of view, they then counted the number of capillaries associated with each type of muscle fibre.

This allowed the researchers to calculate the mean number of capillaries for each type of muscle fibre, for each age group.

The table below shows the researchers' results which include standard deviation (SD).

Hamster age group	**Number of hamsters in group**	**Mean number of capillaries associated with each type of muscle fibre**	
		Slow fibres (± SD)	**Fast fibres (± SD)**
Young	9	3.4 (±0.8)	4.0 (±0.8)
Adult	10	4.7 (±0.2)	6.3 (±0.4)
Old	8	4.6 (±0.9)	6.8 (±0.6)

(a) Give **four** precautions that the researchers took to make their calculations of mean number of capillaries per fibre reliable.

1 .....

.....

2 .....

.....

3 .....

.....

4 .....

.....

(4)

(b) The researchers examined the muscle of an animal in the **old** age group. They found one field of view containing only slow muscle fibres. They counted 69 capillaries in this field of view.

(i) Use a calculation to estimate how many slow muscle fibres were visible in this field of view. Show your working.

Number of slow muscle fibres = ...

(2)

(ii) The actual number of slow muscle fibres in the field of view was **not** the same as the number you calculated in question (i).

Give **one** reason why.

.....

.....

.....

(1)

(c) A student read the report of the researchers' investigation. She thought that the investigation was unethical but that a conclusion could still be made.

(i) Suggest why she thought the investigation was unethical.

.....

.....

.....

(1)

(ii) She concluded that age had a significant effect on the mean number of capillaries per fibre.

Evaluate this conclusion.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(4)
(Total 12 marks)

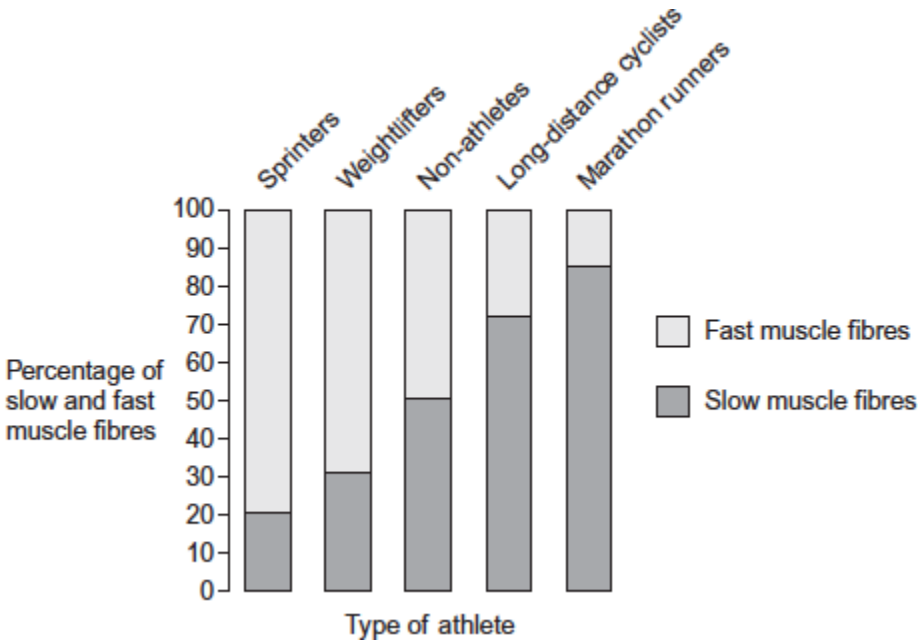
4 It is believed that each person is born with a certain percentage of slow and fast muscle fibres in their skeletal muscles. Most people have about 50% slow fibres and 50% fast fibres.

A sports scientist wondered if these percentages could change over time depending on the type of sport in which a person was involved. He knew from previous investigations that:

- the number of mitochondria within a fibre can change
- the diameter of a fibre can change
- the number of muscle fibres in a skeletal muscle remains constant over time.

He determined the mean percentages of slow and fast fibres in skeletal muscles of different types of athletes.

His results are shown in the graph below in the form in which he presented them.



(a) (i) In which type of athlete would the sports scientist expect to find muscle fibres with the highest number of mitochondria?

.....

(1)

(ii) Explain the reason for your choice of athlete.

.....

.....

.....

.....

(2)

(b) The leg muscles of long-distance cyclists are usually larger than the leg muscles of non-athletes.

Suggest why.

.....

.....

.....

.....

.....

.....

[Extra space] .....

.....

.....

(3)

(c) A reader of the sports scientist's results stated that 'the results show that regular weightlifting changes your proportion of slow and fast skeletal muscle fibres.'

Do you agree with this statement? Explain your answer.

.....

.....

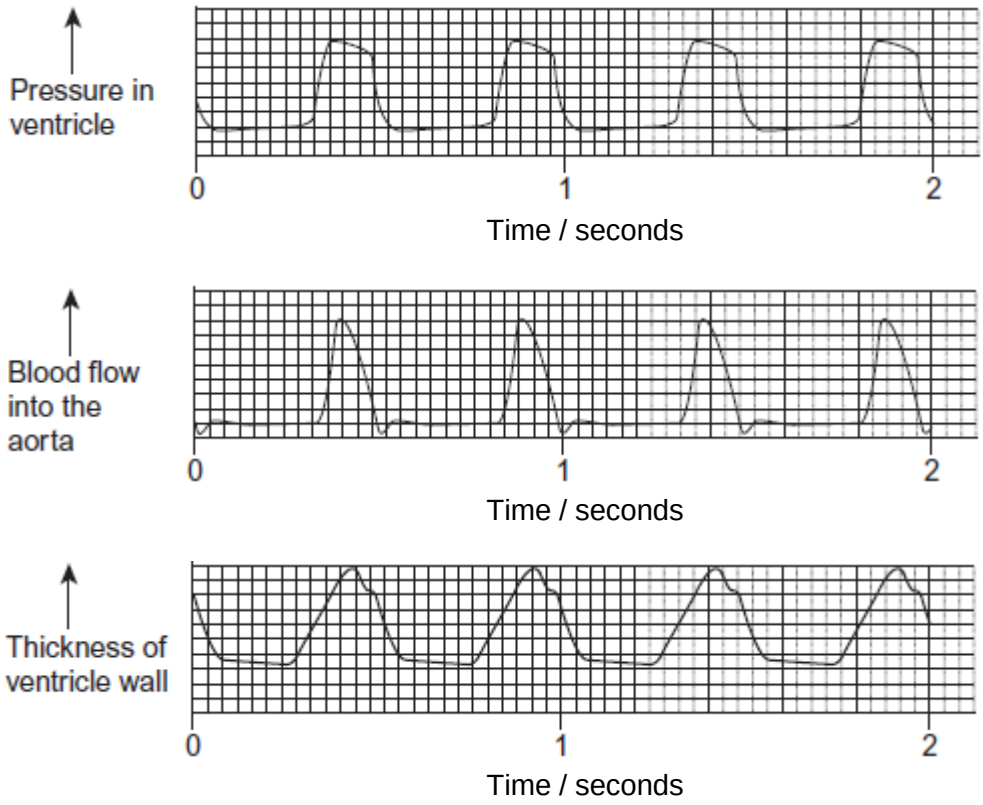
.....

.....

.....

(2)
(Total 8 marks)

5 The figure below shows recordings made from the heart of a dog.



(a) Use information from the figure to explain how the pressure in the dog's ventricle is related to blood flow into the aorta.

.....

.....

.....

.....

(Extra space) .....

.....

(2)

(b) Use information from the figure to explain how the pressure in the dog's ventricle is related to the thickness of the ventricle wall.

.....

.....

.....

.....

(Extra space) .....

.....

(2)

(c) Use the figure to calculate the heart rate of the dog in beats per minute.
Show your working.

Heart rate ..... beats per minute

(2)
(Total 6 marks)

6 Some mice have diabetes. The diabetes causes the blood glucose concentration to become very high after a meal. Scientists investigated the use of an inhibitor of amylase to treat diabetes.

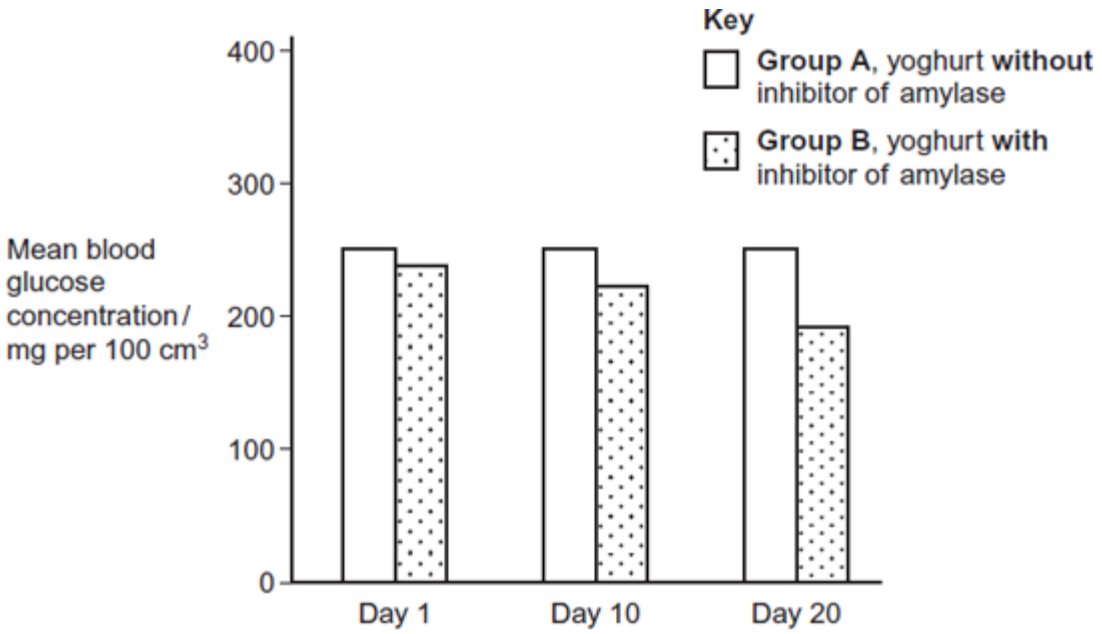
The scientists took 30 mice with diabetes and divided them into two groups, **A** and **B**.

- **Group A** was given yoghurt **without** the inhibitor of amylase each day.
- **Group B** was given yoghurt **with** the inhibitor of amylase each day.

Apart from the yoghurt, all of the mice were given the same food each day.

The scientists measured the blood glucose concentration of each mouse, 1 hour after it had eaten. This was done on days 1, 10 and 20 after the investigation started.

The following figure shows the scientists' results.



(a) **Group A** acted as a control in this investigation.

Explain the purpose of this group.

.....

.....

.....

.....

(2)

(b) Apart from the yoghurt, it was important that all of the mice were given the same food each day.

Give **two** reasons why it was important that all of the mice were given the same food each day.

1 .....

.....

2 .....

.....

(2)

(c) The scientists' hypothesis was that adding the inhibitor of amylase to the food would lead to a lower blood glucose concentration.

Use your knowledge of digestion to suggest how the addition of the inhibitor could lead to a lower blood glucose concentration.

.....

.....

.....

.....

(2)

(d) Give **one** reason why these results may **not** support the use of the inhibitor of amylase to treat diabetes in mice.

.....

.....

.....

.....

(2)
(Total 8 marks)

7 A biologist investigated the behaviour of a species of worm that lives in soil.

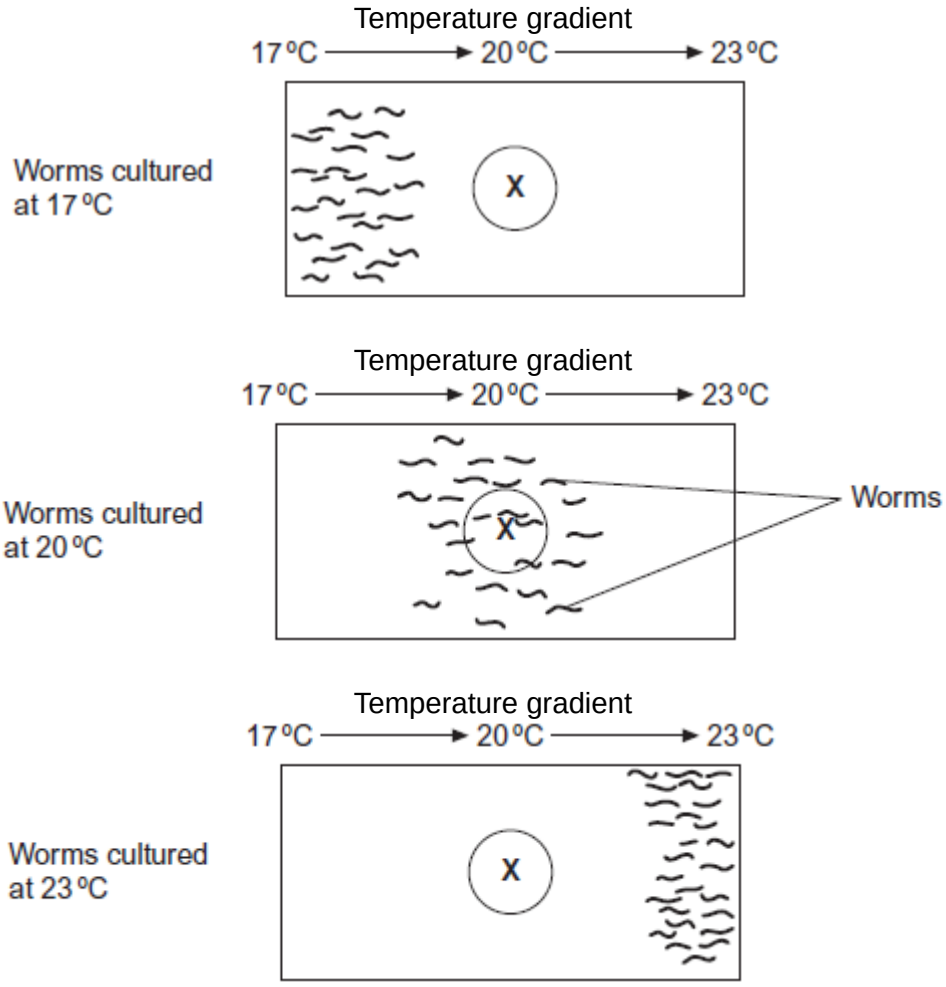
He cultured three samples of worms in three separate trays of soil for many days.
Each culture:

- contained a food supply
- was kept at a different temperature.

The temperatures of the cultures were 17 °C, 20 °C and 23 °C.

The biologist then removed food from the trays for several hours. Then he transferred each sample of worms onto a glass surface where there was **no food**. Each surface had a temperature gradient across it. After 1 hour, the biologist recorded the position of each worm.

The figure below shows his results. On each diagram, (X) marks where he released the worms onto the glass surface.



(a) The biologist concluded that the worms' behaviour demonstrated taxis.
How do these results support this conclusion?

.....

.....

.....

.....

(2)

(b) Using the information provided, suggest an explanation for the worms' behaviour on the glass surfaces in the absence of food.

.....

.....

.....

.....

.....

.....

(Extra space) .....

.....

.....

(3)

(c) In each experiment, the biologist exposed the surfaces to light that was dim and even, so he could see where the worms went.

Apart from seeing where the worms went, suggest **two** reasons why it was important that the light was dim and even.

1 .....

.....

2 .....

.....

(2)
(Total 7 marks)

8 (a) A myelinated axon conducts impulses faster than a non-myelinated axon. Explain this difference.

.....

.....

.....

.....

.....

.....

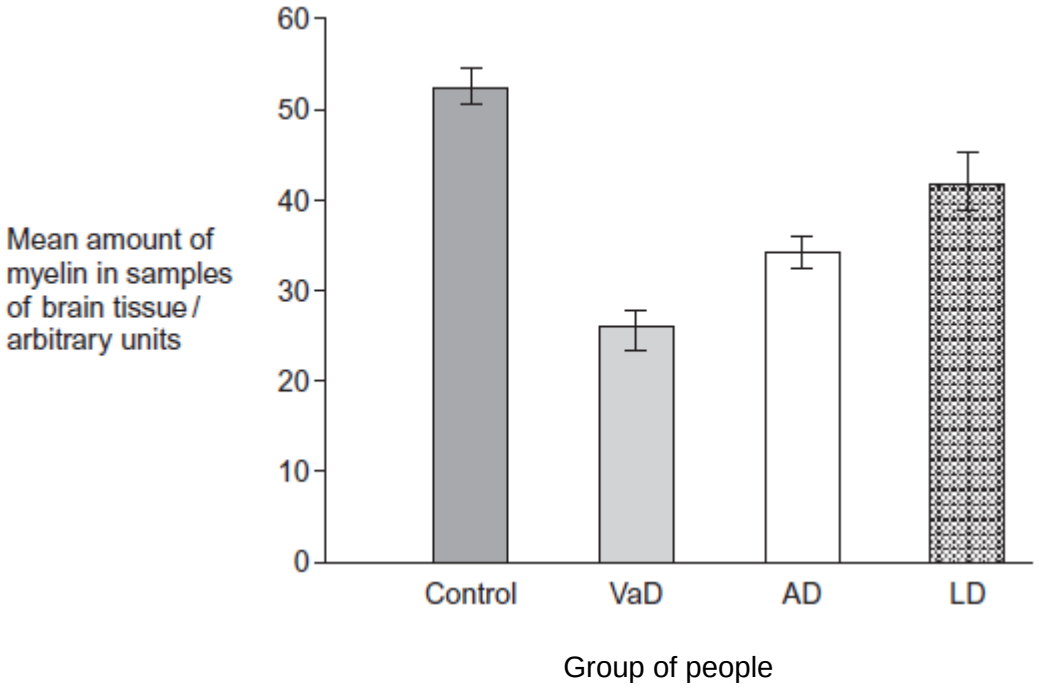
(3)

Doctors investigated the relationship between myelin in brain tissue and different types of dementia. All types of dementia involve loss of mental ability.

The doctors measured the mean amount of myelin in samples of brain tissue from:

- a control group of 12 people without dementia
- 20 people with vascular dementia (VaD)
- 19 people with Alzheimer's dementia (AD)
- 31 people with Lewy body dementia (LD).

The doctors' results are shown in the figure. The vertical bars show standard errors.



(b) The doctors used a statistical test to compare the results for AD and LD.
They obtained a value for P of 0.047.

What does this result show about the difference between the means for AD and LD?

Use the words **probability** and **chance** in your answer.

.....

.....

.....

.....

(2)

(c) A student who read this investigation concluded that there was a relationship between the amount of myelin in a person's brain and whether or not they had dementia.

Do these data support this conclusion? Give reasons for your answer.

.....

.....

.....

.....

.....

.....

.....

.....

(Extra space) .....

.....

.....

.....

(4)
(Total 9 marks)

9 (a) When insulin binds to receptors on liver cells, it leads to the formation of glycogen from glucose. This lowers the concentration of glucose in liver cells.

Explain how the formation of glycogen in liver cells leads to a lowering of blood glucose concentration.

.....

.....

.....

.....

(2)

People with type II diabetes have cells with low sensitivity to insulin. About 80% of people with type II diabetes are overweight or obese. Some people who are obese have gastric bypass surgery (GBS) to help them to lose weight.

Doctors investigated whether GBS affected sensitivity to insulin. They measured patients' sensitivity to insulin before and after GBS. About half of the patients had type II diabetes. The other half did not but were considered at high risk of developing the condition.

The table below shows the doctors' results. The higher the number, the greater the sensitivity to insulin.

Patients	**Mean sensitivity to insulin / arbitrary units (± SD)**	
	Before gastric bypass surgery	**1 month after gastric bypass surgery**
Did not have diabetes	0.55 (± 0.32)	1.30 (± 0.88)
Had type II diabetes	0.40 (± 0.24)	1.10 (± 0.87)

(b) The doctors concluded that many of the patients who did not have type II diabetes were at high risk of developing the condition.

Use the data in the table to suggest why they reached this conclusion.

.....

.....

.....

.....

(2)

(c) The doctors also concluded that GBS cured many patients' diabetes but that some were not helped very much.

Do these data support this conclusion? Give reasons for your answer.

.....

.....

.....

.....

.....

.....

(Extra space) .....

.....

.....

(3)
(Total 7 marks)

10 (a) What is the role of phosphocreatine (PC) in providing energy during muscle contraction?

.....

.....

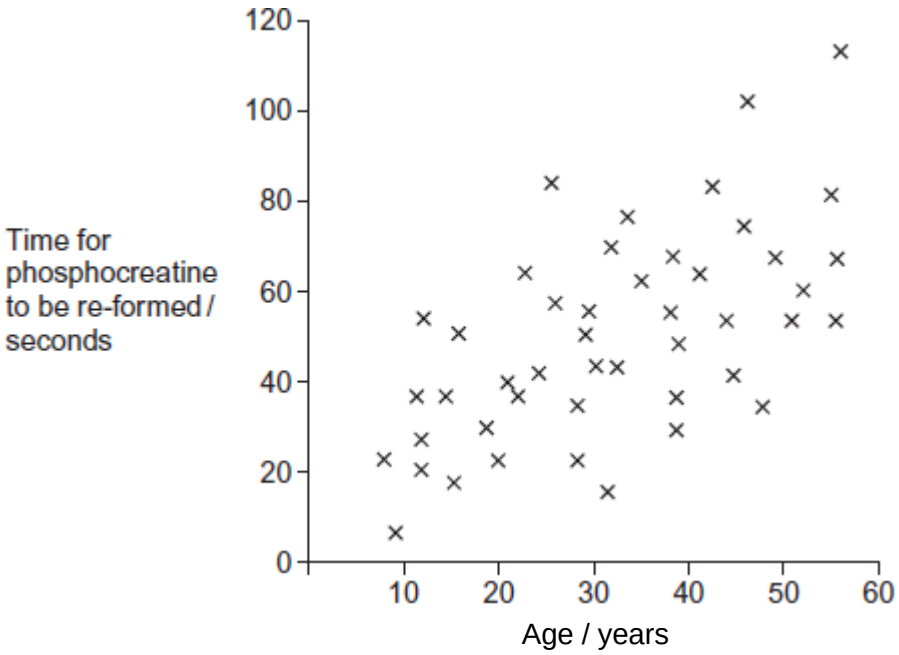
.....

.....

(2)

Scientists investigated the time for phosphocreatine (PC) to be re-formed in arm muscles after the same exercise in healthy people of different ages. The exercise involved brief, rapid contractions of arm muscles.

The figure below shows the scientists' results. Each cross is the result for one person.



(b) There is a lot of variation in the time taken for PC to be re-formed in people of a very similar age.

Suggest **one** reason for this variation.

.....

(1)

(c) Use your knowledge of fast muscle fibres to explain the data in the figure.

.....

.....

.....

.....

.....

.....

.....

.....

(Extra space) .....

.....

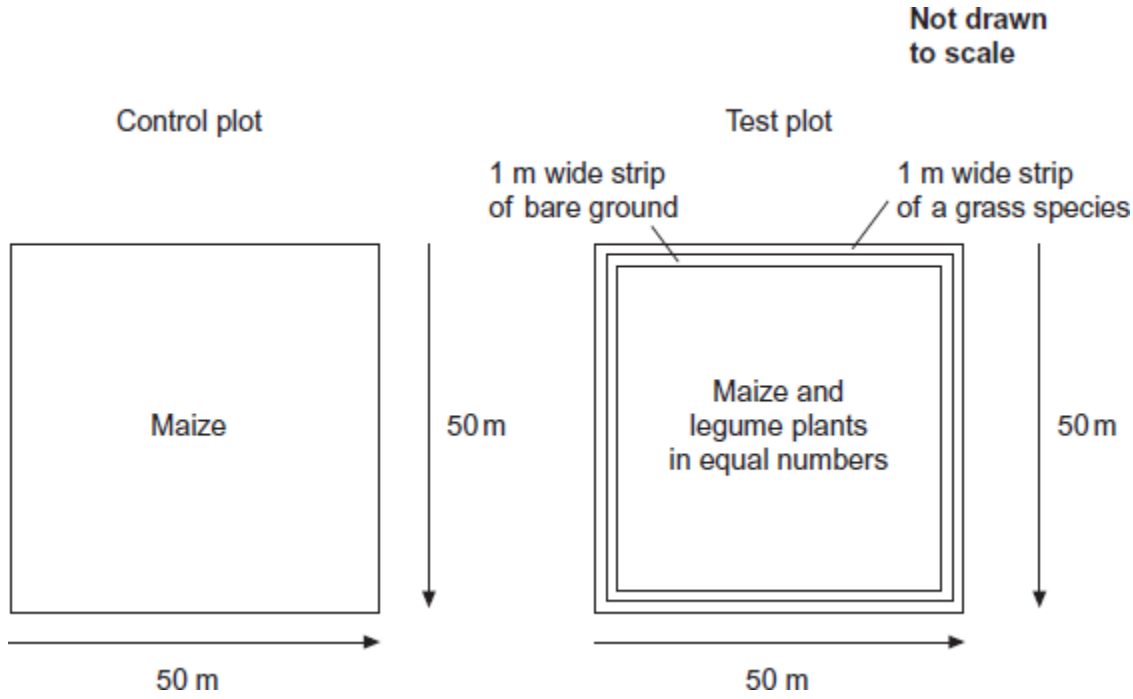
.....

.....

(4)
(Total 7 marks)

11 Stemborers are insect pests that feed on maize plants. Scientists investigated the effect of **push-pull** stimuli on the control of these pests.

For this investigation, the scientists divided a large field into plots measuring 50 m × 50 m. They then designated each plot as a control plot or a test plot. The following figure shows what they planted in each type of plot.



The legumes planted with the maize drive stemborers away.
The grass species attracts stemborers.

The table below shows the scientists' results.

Plots	Mean percentage damage to maize plants	Mean maize grain yield / tonnes per hectare (± standard deviation)	Mean production costs per farmer / $ per hectare (± standard deviation)	Mean total income for farmer / $ per hectare (± standard deviation)
Control	29.6	1.5 (±0.2)	250 (±0.7)	329 (±5.9)
Test	6.7	3.7 (±0.3)	278 (±1.1)	679 (±10.2)

(a) In the test plot of land, identify the push stimulus and the pull stimulus.

Push stimulus .....

Pull stimulus .....

(1)

(b) When measuring the mean percentage damage to maize plants, 60 plants from each test plot were selected at random and examined.
Describe how the maize plants could be selected at random.

.....

.....

.....

.....

.....

.....

(Extra space) .....

.....

.....

(3)

(c) In the test plot, bare ground was left between the maize and the grass species.
Suggest an explanation why.

.....

.....

.....

.....

.....

(2)

(d) The legume plants have nodules containing nitrogen-fixing bacteria on their roots.
Explain how nitrogen-fixing bacteria could increase the growth of the maize.

.....

.....

.....

.....

.....

(2)

(e) A year after this investigation, the government of one country decided that their farmers should use these **push-pull** stimuli.
How do these data support this decision?

.....

.....

.....

.....

.....

.....

(Extra space) .....

.....

.....

(3)
(Total 11 marks)

12 The body loses heat quickly in cold water. A researcher investigated the effect of length of time in a bath of ice-cold water on the reaction times of 20 healthy people aged between 21 and 23 years of age.

She measured each person's reaction time after being left in ice-cold water for 15, 30 or 45 seconds. She also recorded each person's reaction time before being placed in the ice-cold water (0 seconds).

The table shows her results.

Length of time in bath of ice-cold water / seconds	Mean reaction time / seconds	Standard error
0	0.395	0.0124
15	0.301	0.0105
30	0.297	0.0212
45	0.326	0.0183

(a) (i) One reason that reaction time is slower when body temperature falls is because nerve impulse conduction is slower. Explain how a lower temperature leads to slower nerve impulse conduction.

.....

.....

.....

.....

(2)

(ii) Other than temperature, give **two** factors that affect the speed of nerve impulse conduction.

1 .....

2 .....

(2)

(b) Suggest the conditions that the researcher used when obtaining her data for 0 seconds.

.....

.....

.....

(1)

(c) Explain how the researcher could use her **raw** data to find

(i) the mode .....

.....

(ii) the range .....

.....

(2)

(d) A student reading the researcher's report concluded that the difference between the results for 30 seconds and 45 seconds was significant. Do you agree with his conclusion? Explain your answer.

.....

.....

.....

.....

.....

.....

(Extra space) .....

.....

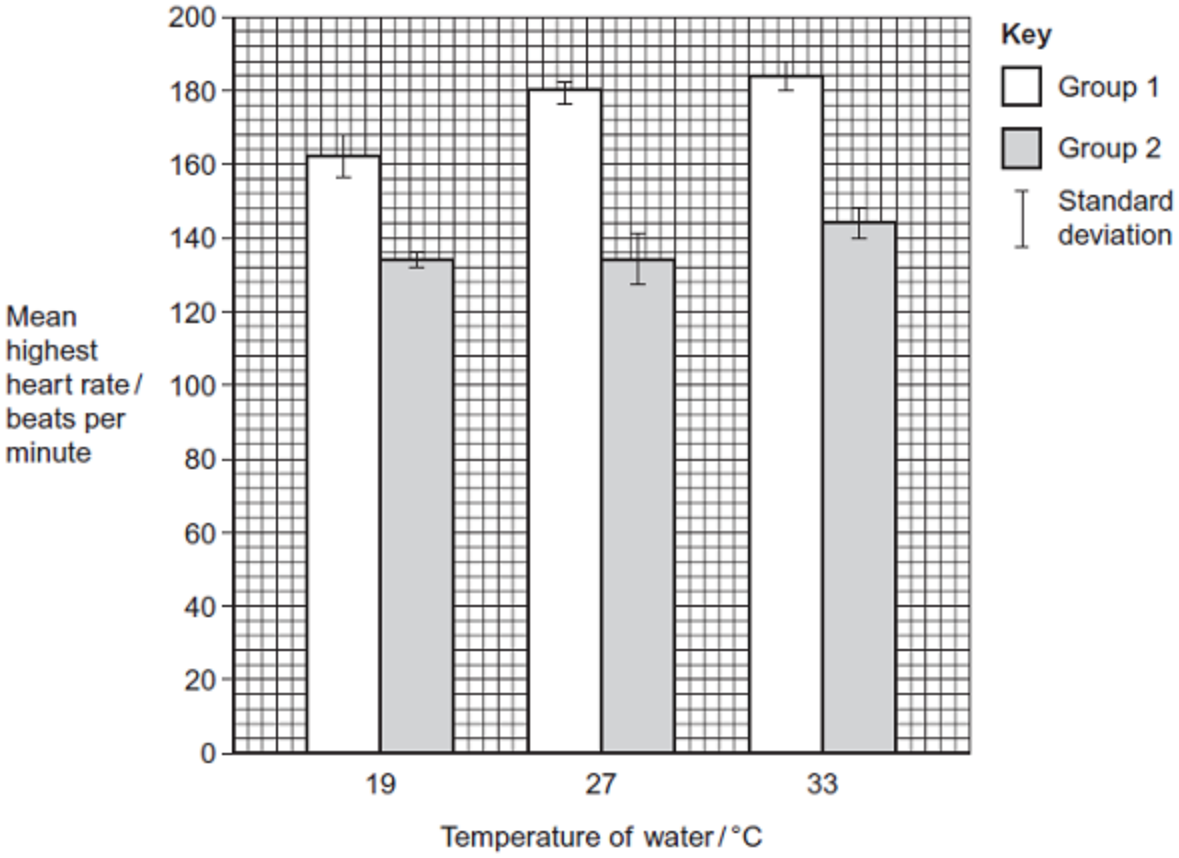
.....

(3)
(Total 10 marks)

13 Scientists investigated the effects of water temperature on the heart rate of swimmers.
Two groups of volunteers were asked to repeat the same swim at three different temperatures.

- **Group 1** volunteers were asked to swim 100 m as quickly as they could.
- **Group 2** volunteers were asked to swim continuously for 30 minutes.

The scientists recorded the highest heart rate for each swimmer during each swim.
Their mean results are shown in the following figure.



(a) Give **one** conclusion that can be made from the scientists' investigation.

.....

.....

.....

(1)

(b) After reading the scientists' report, a member of a swimming club stated that "the report shows that swimming flat out is better for you than swimming for a length of time." Evaluate this statement.

.....

.....

.....

.....

.....

.....

.....

.....

(Extra space) .....

.....

.....

.....

(4)
(Total 5 marks)

14 (a) Describe how a heartbeat is initiated and coordinated.

(5)

(b) Explain how the heart muscle and the heart valves maintain a one-way flow of blood from the left atrium to the aorta.

(5)
(Total 10 marks)